

Citation for published version:

Borsci, S, Kuljis, J, Barnett, J & Pecchia, L 2016, 'Beyond the user preferences: Aligning the prototype design to the users' expectations', *Human Factors and Ergonomics In Manufacturing and Service Industries*, vol. 26, no. 1, pp. 16-39. <https://doi.org/10.1002/hfm.20611>

DOI:

[10.1002/hfm.20611](https://doi.org/10.1002/hfm.20611)

Publication date:

2016

Document Version

Early version, also known as pre-print

[Link to publication](#)

This is the peer-reviewed version of the following article: Borsci, S, Kuljis, J, Barnett, J & Pecchia, L 2014, 'Beyond the user preferences: Aligning the prototype design to the users' expectations' *Human Factors and Ergonomics In Manufacturing and Service Industries*., which has been published in final form at <http://dx.doi.org/10.1002/hfm.20611>. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Self-Archiving.

University of Bath

Alternative formats

If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

See discussions, stats, and author profiles for this publication at: <http://www.researchgate.net/publication/269578516>

Beyond the User Preferences: Aligning the Prototype Design to the Users' Expectations

ARTICLE in HUMAN FACTORS AND ERGONOMICS IN MANUFACTURING · DECEMBER 2014

Impact Factor: 0.86 · DOI: 10.1002/hfm.20611

READS

23

4 AUTHORS:



[Simone Borsci](#)

Imperial College London

56 PUBLICATIONS 148 CITATIONS

[SEE PROFILE](#)



[Jasna Kuljis](#)

Brunel University London

80 PUBLICATIONS 771 CITATIONS

[SEE PROFILE](#)



[Julie Barnett](#)

University of Bath

110 PUBLICATIONS 940 CITATIONS

[SEE PROFILE](#)



[Leandro Pecchia](#)

The University of Warwick

56 PUBLICATIONS 300 CITATIONS

[SEE PROFILE](#)

Beyond the user preferences: Aligning the prototype design to the users' expectations

Simone Borsci¹, Jasna Kuljis¹, Julie Barnett² and Leandro Pecchia³

¹*Brunel University, School of Information Systems, Computing and Mathematics, Kingston Lane, Uxbridge, Middlesex UB8 3PH, UK*

²*University of Bath, Department of Psychology, Bath, BA2 7AY, UK*

³*University of Warwick, School of Engineering, Coventry, CV4 7AL, UK*

Corresponding author: Simone Borsci, email: simone.borsci@gmail.com, tel.: +44 (0)1895 276487, present address: Brunel University, School of Information Systems, Computing and Mathematics, Kingston Lane, Uxbridge, Middlesex UB8 3PH, UK.

Keywords

User preference; Perceived usability; Perceived aesthetics; User intention to purchase; Pre-use appraisal.

Abstract

It is important for practitioners to conceptualize and tailor a prototype in tune with the users' expectations in the early stages of the design life cycle so the modifications of the product design in advanced phases are kept to minimum. According to user preference studies the aesthetic and the usability of a system play an important role in the user appraisal and selection of a product. However, user preferences are just a part of the equation. The fact that a user prefers one product over the other does not mean that they would necessarily buy it. In

order to understand the factors affecting the user's assessment of a product before the actual use of the product and the user's intention to purchase the product we conducted a study, reported in this article. Our study, a modification of a well-known protocol, considers the users' preferences of six simulated smartphones each with different combination of attributes. A sample consisting of 365 participants was involved in our analysis. Our results confirm that the main basis for the users' pre-use preferences is the aesthetics of the product, whereas, our results suggest that the main basis for the user's intention to purchase are the expected usability of the product. Moreover, our analysis reveals that the personal characteristics of the users have different effects on both the user's preferences and their intention to purchase a product. These results suggest that the designers should carefully balance the aesthetics and usability features of a prototype in tune with the users expectations. If the conceptualisation of a product is done properly the redesign cycles after the usability testing can be reduced and speed up the process for releasing the product on the market.

1. INTRODUCTION

Today, manufacturers have a growing interest in user experience (UX) assessment. In fact, the UX analysis is the only holistic approach that can lead manufacturers to form a full comprehensive picture about “the users’ emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after the use of a product” (ISO 9241-210, ISO, 2010). Although the UX assessment is an expensive process, it may provide valuable insights on how to improve/change the attributes and the functionality of the product in line with users’ needs, and increase the chances of market success (Borsci, Kurosu, Federici, & Mele, 2012, 2013; Kurosu, 2010, 2012a, 2012b; Roto, Law, Vermeeren, & Hoonhout, 2011). The main disadvantage of the UX evaluation is that it can only be performed in advanced stages of the product life cycle, or at the earliest

when a prototype can be manipulated by users. This is at odds with the manufacturers growing need for methods that would help them conceptualise the product attributes (e.g., screen size) and that would help them in assessing the users' reaction to the product before the interaction taking place. This kind of analysis could help designers develop the prototypes that have more chances of matching the expectations and the needs of users. Hence, the analysis of the users' expectations is very important part of the product life cycle because it can reduce the time and effort required to re-design the prototype.

Practitioners who are used in assessing the users' expectations apply qualitative approaches such as focus groups, interviews, in-depth case analysis, or specific structured processes such as technology acceptance models, conjoint analysis, analytic hierarchy process, etc. (see, for instance: Choi & Lee, 2012; Chuang, Chang, & Hsu, 2001; Clodfelter & Fowler, 2001; Han, Kim, Yun, Hong, & Kim, 2004; Işıklar & Büyüközkan, 2007). They rely on these approaches to elicit users' expectations of a system or their reactions to the final product or to its mock-up. Many studies, especially in the Human Computer Interaction (HCI) field, have extensively analysed the preference-making process as the person's appraisal of a product that is based on either users conscious or subconscious reactions to the perceivable attributes of the product (Ben-Bassat, Meyer, & Tractinsky, 2006; Lee & Koubek, 2010, 2011; Sonderegger & Sauer, 2010).

The product's attributes are usually separated into two kinds of cues, as follows (Clodfelter & Fowler, 2001; Haverila, 2011; Richardson, Dick, & Jain, 1994; van den Heuvel, van Trijp, van Woerkum, Jan Renes, & Gremmen, 2007):

- Intrinsic cues, intended as all attributes that comprise a device or an interface functioning. For instance, to assess the “readability of the text” on a website could be done by observing the reaction of the users to the intrinsic cues “font type” and “font

size”. The intrinsic cues are the all the perceivable attributes and information that lead users to judge the (expected) quality in the use of a product.

- Extrinsic cues, intended as all the product-related attributes such as: price/ perceived value, brand appeal, level of advertising, packaging etc. For instance, an extrinsic cues of a website is its popularity on the search engines.

Practitioners are used to gather data about the users’ reactions to the product’s attributes, both before and after the use in order to obtain a comparative measure of users pre-use or post-use preferences (Lavie & Tractinsky, 2004; Lee & Koubek, 2010, 2011; Sonderegger & Sauer, 2010; Tractinsky, 1997; Tractinsky, Cokhavi, Kirschenbaum, & Sharfi, 2006).

However, researchers are used to test the user preferences by measuring very different factors, as Lee and Kubeck (2010) recently claimed in their detailed review. A large proportion of the researchers measured the preferences as the overall user’s assessment of a product through a variety of the intrinsic cues that comprise the usability and the aesthetic characteristics of the product. In these kind of studies, the usability is considered as the extent to which the product use is perceived to be effective, efficient and satisfactory in a specific context of use (ISO 9241-11, 1998). The product aesthetics is considered as the response to the holistic image of the product in which all user judgments of the intrinsic attributes of the product and the affective response to these cues are integrated (i.e., visual Gestalt of the object, see: Hassenzahl, 2008).

Although, there is an overall agreement of the importance of the usability and the aesthetics for determining the user preferences of free technologies – such as websites, cash machine etc. – a growing number of studies (Ben-Bassat et al., 2006; De Angeli, Hartmann, & Sutcliffe, 2009; De Angeli, Sutcliffe, & Hartmann, 2006; Lee & Koubek, 2011; van der Heijden, 2003) have underlined that it is not sufficient to only analyse the users’ reactions to the intrinsic cues. There is significant evidences that the extrinsic cues (Freling, Crosno, &

[Henard, 2011; Haverila, 2011; Işiklar & Büyüközkan, 2007; Wells, Valacich, & Hess, 2011](#)) and the users' personal characteristics (e.g., users' expertise, attitude, navigation style etc. see: [De Angeli et al., 2009; De Angeli et al., 2006; Haverila, 2011](#)) also strongly affect their overall judgments. Moreover, as Ben-Bassat et al. (2006) claimed, for a practitioner to identify which product is preferred by a user over another it does not mean that the user will purchase the preferred product or even select and use the preferred product instead of the other. In light of that, there is another variable strongly correlated with the user preferences ([Ben-Bassat et al., 2006; Haverila, 2011; Taylor & Bearden, 2002](#)) that practitioners have to consider when they perform the overall assessment of the product before the use: the user declared intention to purchase the product. This variable represents the consumer's willingness to buy ([Taylor & Bearden, 2002](#)) or to enter a contract in order to obtain a product. This variable is affected by the perceived value of the product estimated by users as a trade-off between the perceived quality and the price or a periodic cost of the product (Dodds, Monroe, & Grewal, 1991; Grewal, Monroe, & Krishnan, 1998; Taylor & Bearden, 2002). The aim of the work reported here was to identify a way to understand and, empirically assess, the user's preferences and intention to purchase before the use of a product; we used a smartphone in the early stage of design as a test case. To address this aim we modified a well-known empirical protocol, proposed by Lee and Koubek (2010, 2011), that is usually applied for testing the preferences of websites through the elicitations of the users' reactions to the variations of the interface intrinsic cues (i.e., levels of usability and aesthetics). The modification of the protocol required two stages:

- analysis in which we developed an experimental model of user preferences;
- empirically determining the levels of usability, aesthetics, and price (intrinsic and extrinsic cues) for each phone from a set of simulated smartphone models.

2. PROTOCOL FOR ANALYSING THE USER PREFERENCES AND INTENTION TO PURCHASE

It is not uncommon for the researchers to use a set of simulated devices with different levels of usability and aesthetics in order to test the user preferences (Dillon; Kurosu & Kashimura, 1995; Lavie & Tractinsky, 2004; Sonderegger & Sauer, 2010; Tractinsky, 1997). These device models are created through an artificial modification of the quality of the attributes of the system (i.e., specifications). Usually the researchers create their simulated systems by variation of all-high vs. all-low specifications of each attribute of a system. That process allows researchers to create models of a product for which the attributes have various levels of specifications, hence the simulated systems have different levels of usability and aesthetics on the basis of their specifications, as Table 1 shows.

TABLE 1. Simulated devices with different usability and aesthetics levels.

Device code	Usability level	Aesthetics level
1	High	High
2	High	Low
3	Low	High
4	Low	Low

During the first stage, so called ‘preferences analysis’, the participants are assigned one of the possible simulated products and are asked to rate (by a questionnaire) the levels of expected usability, aesthetics and the overall preferences. The researchers then analyse the data gathered for all products and compare the effect of the different levels of usability and aesthetics on the preferences.

Lee and Koubek (2010) conducted a comprehensive review of the preference studies and have created a protocol based on a well tested set of items for measuring the

relationships among the usability, the aesthetics and the preferences (see: Lee & Koubek, 2010, 2011; Sonderegger & Sauer, 2010). They proposed to measure, the levels of users' preferences through a questionnaire, by also controlling:

- the personal characteristics of the users by a set of questions carried out by the demographic section of the Questionnaire for User Interaction Satisfaction (QUIS, see: Harper, Slaughter, & Norman, 1998; see also Appendix 1, items Q1-Q10);
- the rate of the usability by an adapted set of eight questions, widely used in preferences studies, originally from the Post-Study System Usability Questionnaire (PSSUQ, Lewis, 1991, 1995; 2002; see also Appendix 1, items 1-8);
- the level of the aesthetics by a set of eleven items from the findings by Lavie and Tractinsky's (2004; see also Appendix 1, items 9-18).

This protocol was intended only for the preferences analysis of free technology, and therefore did not include any questions for measuring the extrinsic cues, nor for measuring the perceived value and the user's intention to purchase. Hence, we enhanced the protocol of Lee and Koubek (2010, 2011) to include a set of five items (items 20-24, see Appendix 1,) usually used in marketing and decision making studies (see, for instance: Martínez Salinas & Pina Pérez, 2009; Sattler, Völckner, Riediger, & Ringle, 2010; Taylor & Bearden, 2002) to control the relationship among price of the product, its perceived value, and the intention to purchase or make a contract as declared by the users.

This adapted protocol allowed us to empirically investigate the relationships among the personal characteristics, the user's reactions to intrinsic and extrinsic cues (i.e., perceived usability, aesthetics and value of the product) and the user's preferences and intention to purchase.

3. HYPOTHESES

Several studies of free technologies (e.g., web sites, cash machines etc.) showed that the expected aesthetics was highly correlated with the expected usability (Ben-Bassat et al., 2006; Kurosu & Kashimura, 1995; Tractinsky, 1997; Tractinsky, Katz, & Ikar, 2000). Moreover as Ben-Bassat et al. (2006) suggested, by testing purchasable products, the perceived value of a device is mostly affected by the users' perceived usability rather than to the aesthetics. Users base their pre-use preferences mostly on the product's aesthetics because they cannot accurately judge the level of the usability of the device before being able to interact with it (Ben-Bassat et al., 2006; Lee & Koubek, 2010, 2011; Sonderegger & Sauer, 2010).

As some empirical studies of smartphone suggested, the price of a product is a key factor for determining the overall user preferences (Ben-Bassat et al., 2006; Işıklar & Büyüközkan, 2007). There is consistent evidence suggesting that the price of a product affected not only the user's preferences but also its perceived value (Richardson et al., 1994; Sattler et al., 2010; Taylor & Bearden, 2002). Moreover, as Ben-Bassat and colleagues (2006) point out, preferring something and purchasing something are two different processes. In fact, the users' preferences are mostly based on their observation and assessment of the intrinsic and extrinsic cues of a device, while the declared intentions to purchase are affected not just by their overall preferences but also by the perceived value of a product (Ben-Bassat et al., 2006; Taylor & Bearden, 2002)

Albeit some studies (De Angeli et al., 2009; De Angeli et al., 2006; Lee & Koubek, 2010, 2011; Tractinsky, 1997) have shown that the user's personal characteristics may affect the expected usability or aesthetics. However, the effect of these factors on the overall preferences is still unclear. At the same time, a lot of researchers have underlined that the personal factors such as users' previous experience and expertise in use affect both the

perceived value of a product and the user's intentions to purchase (Clodfelter & Fowler, 2001; De Angeli et al., 2006).

Based on these findings from the literature our experimental design was developed to test the following four hypotheses:

Hypothesis 1: Before the use, there is a high correlation among the user's reactions to the cues (expected¹ usability, aesthetics and perceived value). The aesthetics and usability are strongly correlated (e.g., the perceived usability and value of the product). While the perceived aesthetics and the perceived value of the product are either only marginally correlated or not at all.

Hypothesis 2: The overall user preferences before the actual use are significantly affected by the variation of the products' levels of aesthetics, while the variation of the usability does not affect the user preferences.

Hypothesis 3-1: The price of a product affects both the reactions of the users to the cues and the users' preferences before the use.

Hypothesis 3-2: The users' intentions to purchase a product is significantly affected by their declared preferences and perceived value of the product, but is only marginally affected by the product's price and its levels of usability/aesthetics.

Hypothesis 4-1: The personal characteristics of the participants do not affect the overall user preferences before the use, while these factors could affect their expected aesthetics or usability before the use (or both).

Hypothesis 4-2: The personal characteristics affect the perceived value of a product before the use, as well as the users declared intention to purchase the product.

¹ We use in this work the terms "expected usability or aesthetics" to indicate the usability or aesthetics perceived by a user before the use of a product on the basis of the device perceivable intrinsic cues.

To test these hypotheses, we need to create a set of models (i.e., the simulated smartphones). The studies reported in academic literature on the relationship between smartphone attributes and users' assessment of the product mostly measured the effect of the variation of the specifications of the phone's attributes on the users selection of a product. A large number of these studies focus on the relationship between attributes and user satisfaction (Chae & Kim, 2004; Choi & Lee, 2012; Chuang et al., 2001; Han et al., 2004; Ngo, Teo, & Byrne, 2003), while only few studies analyse the relationship among the product's attributes and the user preferences (Seva & Helander, 2009; Zhu, Wang, Yan, & Wu, 2009). Although the researchers generally agree that the specifications of the product's attributes have an effect on both the satisfaction and the preferences, there are no studies that would provide a systematic empirical analysis of the relationship among the product attributes, the users preferences and intention to purchase a phone before the use.

That is why we have decided to undertake two pre-experimental phases in order to select the attributes of our experimental device models. The first phase aimed at identifying the smartphone attributes that affect the users' appraisal of the usability and aesthetics before the actual use, and the specification of the its attributes they would perceive as high or low in terms of the device performance. For instance, we need to understand if the user considers the product attribute 'Type of connectivity' as an aesthetics or a usability characteristics of a smartphone and to establish whether 'Wi-Fi and 3G' is considered as a high or a low performance's value of a smartphone specification with compared to, for instance, '3G', during a pre-use assessment. This process allows us to identify, and to manipulate independently (Ben-Bassat et al., 2006), the high and low levels of usability and aesthetics in order to compose four models of smartphones in line with the classic approach of all-high vs. all-low specifications (see Table 1).

The second pre-experimental phase deals with the recommendation from Ben-Bassat et al. (2006) to create simulated devices that are not only composed of blocks of all-high/low specifications, but also provide alternative device models with medium levels of usability and aesthetics (i.e., mixed levels). In this phase, by ranking the product attributes through a structured process of pairwise comparison (i.e., Analytic Hierarchy Process), we have created two new models of smartphones in which the specifications' values (high and low) of the device are selected on the basis of the rank of each attribute.

As the result of these two phases our final experimental tool was composed of six smartphone models (simulated devices): four models were composed of all high or all low specifications, and two models were composed of a mix of high and low specifications.

4. METHODS

The pre-experimental and experimental phases were conducted from January to April 2013; an overall sample consisted of 365 participants (112 males, 253 females; Age M: 25.99, SD: 8.33). All the participants were recruited through social networks of groups and associations and by two universities' websites (Brunel University, London, UK and University of Perugia, Italy).

In the first pre-experimental phase 184 participants were involved (55 males, 129 females, Age M: 25.02, SD: 7.53), and in the second phase 66 participants (30 males, 36 females, Age M: 26.04, SD: 6.33). Finally, 60 participants were involved in the main experiment (28 males, 32 females, Age M: 25.54, SD: 7.21). 55 participants were excluded for errors, or incomplete answers, in the questionnaire.

4.1. First pre-experimental phase

We compared the description of smartphones on 20 websites specialising in mobile phones in several countries (.com, .co.uk, .it, .es, .fr). From this comparison we extrapolated a list of 15 smartphone attributes that appear on at least 80% of the websites. We have also included in the list three attributes – the availability of a user guide, the availability on the market of accessories for increasing the product durability and safety, and for personalizing the device aspect – that have been identified as important in previous studies (Choi & Lee, 2012; Chuang et al., 2001; Işıklar & Büyüközkan, 2007; Reinecke & Bernstein, 2011). We excluded from our list all those attributes that could lead participants to think about the phone brand, such as the brand name and operative system of the device. Our final list was composed of 18 attributes (see Appendix 2). We asked three experts with more than 5 years of experience about smartphone design to define two values for each one of the selected attributes: the high and the low level in terms of performance. For instance for the attribute “Type of connectivity”, the selected high value was “Wi-Fi and 3G” and the low was “3G” (see Appendix 2).

Our on-line survey consisted of two sections. In the first section, we asked participants to assess how important was for them to know or be able to retrieve information and specifications about each attribute in the list for judging the device usability and the aesthetics when they are about to purchase or select a smartphone contract. The questions were presented in a random order to each participant, and they have to provide for each attribute their rate for the usability and their rate for the aesthetics on a 7- point Linker scale (from ‘Not at all Important’ to ‘Extremely Important’). In the second section, we asked participants to choose between two specifications for each attribute the one they consider as the worse of the two.

We performed a descriptive statistics and a sample pair t-test analysis to discriminate the attributes considered as important for the users before the use in order to judge the

smartphone usability and aesthetics (see Table 2). Moreover, we applied a bootstrap resampling method with 1000 iterations, for comparing the descriptive statistics obtained from the original and the bootstrapped sample. The bootstrap method is widely used in applied research to increase the interval of confidence and to make a more reliable statistical inferences (Good, 2000; Linden, Adams, & Roberts, 2005). This methods, differently from other predictive techniques based on data simulation, “re-samples with replacement from the original values and generates multiple bootstrap samples as a proxy to the independent real sample” (Akins, Tolson, & Cole, 2005).

We then performed a frequency analysis to discriminate for each attribute the specifications a user perceived as high or low in terms of the performance (see Table 3).

TABLE 2. Attributes that affect the pre-use appraisal of the device usability (U), aesthetics (A) and both those aspects.

Attribute code		Sample			Bootstrapped sample			Final selection
		M	Med	SD	M	Med	SD	
F1 Speed of processing	U	5.19	6	1.72	5.19	5.91	1.70	Usability
	A	3.39	4	1.64	3.39	3.53	1.63	
F2 Memory (in Gb)	U	5.40	6	1.31	5.40	5.84	1.30	Usability
	A	4.32	5	1.71	4.32	4.56	1.69	
F3 Capacity to extend memory	U	5.23	6	1.55	5.24	5.58	1.54	Usability
	A	3.78	4	1.64	3.78	3.94	1.63	
F4 Cam resolution and zoom	U	5.30	6	1.59	5.30	5.94	1.58	Usability
	A	3.86	4	1.74	3.86	4.00	1.73	
F5 Type of connectivity	U	6.10	7	1.33	6.11	6.73	1.32	Usability
	A	4.21	4	1.92	4.20	4.01	1.90	
F6 Battery durability	U	6.40	7	0.97	6.40	7.00	0.96	Usability
	A	3.94	4	1.92	3.94	3.99	1.90	
F7 Display resolution	U	5.55	6	1.32	5.55	5.98	1.31	Usability
	A	4.47	5	1.60	4.47	4.95	1.59	
F8 Connect. with other device	U	5.93	6	1.07	5.92	6.00	1.06	Usability
	A	4.21	4	1.66	4.21	4.37	1.65	
F14 Available native apps	U	4.59	5	1.68	4.60	4.99	1.66	Usability
	A	3.76	4	1.72	3.76	3.99	1.71	
F15 Download new apps	U	5.11	5	1.56	5.11	5.28	1.55	Usability
	A	4.20	4	1.79	4.19	4.14	1.78	
F16 User Guide	U	4.26	4	1.92	4.25	4.11	1.91	Usability
	A	3.14	3	1.71	3.13	3.02	1.70	
F17 Accessories for durability	U	5.08	5	1.67	5.08	5.38	1.66	Usability
	A	4.38	5	1.83	4.38	4.93	1.82	
F12 Device size	U	4.45	5	1.78	4.45	4.63	1.77	Aesthetics
	A	5.34	6	1.53	5.34	5.95	1.52	
F13 Device weight	U	3.95	4	1.80	3.94	4.00	1.79	Aesthetics
	A	4.48	5	1.85	4.49	4.93	1.83	
F18 Accessories for personalize	U	2.92	3	1.63	2.93	2.91	1.63	Aesthetics
	A	4.56	5	1.82	4.57	4.97	1.80	
F9 Camera appearance	U	4.36	5	1.72	4.36	4.86	1.72	Both
	A	4.10	4.6	1.69	4.20	4.50	1.68	
F10 Display size	U	5.13	5	1.53	5.12	5.32	1.52	Both
	A	5.23	5.5	1.49	5.23	5.39	1.48	
F11 Control command	U	5.26	6	1.35	5.75	6.00	1.25	Both
	A	5.01	5.6	1.55	5.37	5.54	1.54	

TABLE 3. Users' discrimination of smartphone's specifications in high (H) and low (L) performance's values.

Attribute code	Specifications	Performance value	User opinion (%)
F1	1.3 GHz	H	100%
	1 GHz	L	--

F2	32 GB	H	100%
	4 GB	L	--
F3	The memory capacity can be extended	H	94.6%
	The memory capacity cannot be extended	L	5.4%
F4	8 Megapixel	H	100%
	3 Megapixel	L	--
F5	Wi-Fi and 3G	H	98.4%
	3G	L	1.6%
F6	10 hours (talk time)	H	100%
	7.5 hours (talk time)	L	--
F7	900X640	H	100%
	800x480	L	--
F8	Bluetooth and USB 2.0	H	100%
	USB 2.0	L	--
F9	On front and back sides	H	96.4%
	Only on front side	L	3.6%
F10	More than 3.6 inches (a large display such as an iPhone, a Samsung Galaxy etc.)	H	92.9%
	2.5 - 3.6 inches (a medium display, such as a BlackBerry, Samsung Ace etc.)	L	7.1%
F11	Touchscreen	H	60.7%
	Keyboard	L	39.3%
F12	Large size device - 2.8x5x0.5 inches (70x127x12 mm)	H	57.1%
	Medium size device - 2.4x4.3x0.4 inches (60x109x10 mm)	L	42.9%
F13	140g (quite light, similar to Samsung Galaxy 3 and iPhone 5)	H	89.3%
	200g (slightly heavy compared to Samsung Galaxy 3 and iPhone 5)	L	10.7%
F14	Many Apps are already installed in the phone by manufacturer	H	67.9%
	A few common Apps are already installed in the phone	L	32.1%
F15	Access to a large database of free and paid applications	H	96.4%
	Access to a small database of free and paid applications	L	3.6%
F16	A paper version of the manual provided with the phone plus an online version	H	100%
	A paper version of the manual not provided with the phone, but available online	L	--
F17	Many accessories available on the market for this model of phone	H	92.9%
	Few accessories available on the market for this model of phone	L	7.1%
F18	Many accessories are available on the market for this model of phone	H	92.9%
	Few accessories are available on the market for this model of phone	L	7.1%

The results of the pre-experimental analysis suggested that a user, before the use of a product, could discriminate only fifteen attributes from the list (F1-F8 and F12-F18) in terms of usability and aesthetics ($p < .001$), while three attributes (F9-F11) were considered equally important for assessing the product's usability and aesthetics. Moreover, the frequency analysis has suggested that there was a strong agreement among the participants in discriminating the high or the low specification for each one of eighteen attributes although in one case (i.e., the feature F12 "Device size") there was an uncertainty between the options.

On the basis of the results of the pre-experimental analysis we composed a preliminary model that represents how consumers, before the use, rely on different intrinsic cues in order to assess smartphone aesthetics and its usability (see Figure 1).

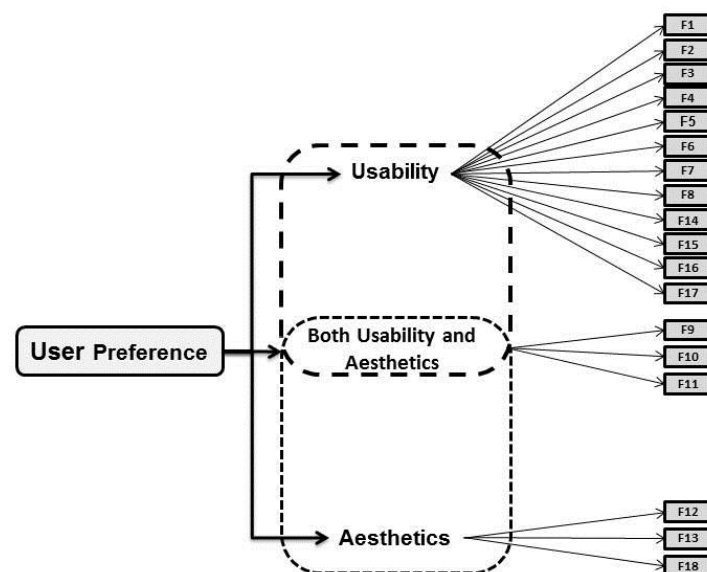


Figure 1 Preliminary model of intrinsic cues

4.2. Second pre-experimental phase

We have performed an Analytic Hierarchy Process (AHP) test for modelling the user preferences of a smartphone before the use. The AHP is a structured and systematic analysis

for quantifying qualitative knowledge by measuring intangible dimensions (Chin, Diehl, & Norman, 1988). It was used for solving multifactor and multidimensional fuzzy problems (Johnson, Firoozbakhsh, Moniem, & Jamshidi, 2001) by measuring the relative importance of elements, i.e., comparing pairs of elements in a hierarchical structure. The AHP is usually carried out by a set of pairwise comparison, and it is proven as more reliable for modelling the decision making than by asking, through direct questions, the participants' judgements about the absolute importance of each element (Glasscock & Wogalter, 2006).

In an AHP test participants are usually invited to observe a model that expresses a set of relationships among different factors, and they are invited for each pair of factors (i, j), to answer the question: "in your opinion i , compared to j is: (1- much less, 2- less, 3- equally, 4- more, or 5- much more) important?" (Yun, Han, Hong, & Kim, 2003).

In this study we applied an AHP test, a well-establish mathematical procedure (Pecchia et al., 2013), to systematically rank the importance of each smartphone attribute by the users when they have to assess a product before the use. To provide a model adapted for the AHP test, we invited two HCI researchers and two experts in the AHP to redesign the preliminary model (Figure 1) by including among the intrinsic cues (i.e., the usability and aesthetics features), also the extrinsic cue of 'device price/monthly cost'.

The visual model observed by the participant during the AHP test, as Figure 2 shows, was composed by four main dimensions²: 'Device price', 'Usability', 'Aesthetics', and 'Usability and Aesthetics'.

Each section of the redesigned model of user preferences was presented to the participants in the on-line questionnaire as a visual aid to help them assess the relative

² We reported here an exemplification of the model, however each dimension of the model is presented to each user in a random order during the assessment carried out by the Analytic Hierarchical Process questionnaire.

importance of each dimension, sub-dimension, and attribute against all the others. For instance, to analyse the importance of the attributes F1, F2 and F3 in the sub-dimension ‘internal features of performance’ (dimension ‘Usability’) we have asked the participants to use the pairwise comparisons to assess the importance of each feature against the others during a selection of a new smartphone (e.g., F1 vs. F2; F2 vs. F3; F3 vs. F1; F3 vs. F2).

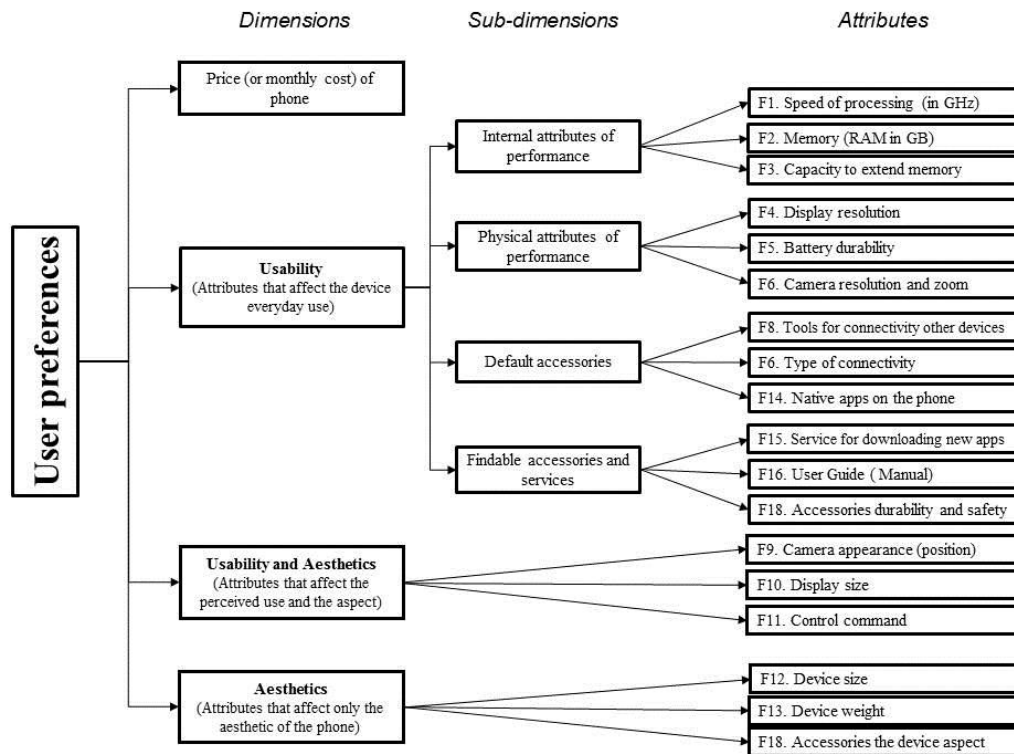


Figure 2 Redesigned model of user preferences before the use of the AHP test

As Table 4 showed, the results of the AHP test strongly supported the findings of previous studies (Kurosu & Kashimura, 1995; Lee & Koubek, 2010, 2011; Schrepp, Held, & Laugwitz, 2006; Sonderegger & Sauer, 2010) that, before the actual use, the users were likely to consider the aesthetic attributes of the device as more important than the others cues. At the same time, in line with the analysis of Ben-Bassat et al. (2006), before the actual use the price of the device was considered by the users more important than the attributes related only to the usability. Moreover, the price was found as less important for selecting a product

than the attributes that related to both the aesthetics and the usability of the device (i.e., F9, F10, F11).

TABLE 4. Outcomes of the Analytic Hierarchy Process test.

Rank between n	Weight Between	Dimension	Rank of sub-dimension	Feature	Rank within	Weight within
1	43%	Aesthetics	---	F12. Device weight	1	51%
			---	F13. Device size	2	27%
			---	F18. Customise/ personalize	3	22%
2	24%	Usability & Aesthetics	---	F10. Display size	1	56%
			---	F9. Camera appearance	2	23%
			---	F11. Control command	3	21%
3	17%	Price	---	---	---	---
4	16%	Usability	1. Findable accessories	F16. User Guide	1	54%
				F17. Durability and safety	2	25%
				F15. Service for download apps	3	22%
			1. Default accessories	F14. Native apps	1	50%
				F8. Connect with other devices	2	29%
				F5. Type of connectivity	3	21%
			2. Internal features	F3. Capacity to extend memory	1	38%
				F2. Memory	2	35%
				F1. Speed of processing	3	26%
			3. Physical features	F4. Camera resolution/zoom	1	50%
				F7. Display resolution	2	30%
				F6. Battery durability	3	20%

On the basis of the rank of attributes, we have created two mixed-models that, differently from the models composed of all-high vs. all-low specifications (see Table 1), were composed of a mixed set of specifications performance's values (see Table 5).

TABLE 5. High and low attributes that composed the mixed models of smartphones.

Dimension	Attribute	Specification of the performance value	
		Device 5	Device 6
Aesthetics	F12. Device weight	High	Low
	F13. Device size	High	Low
	F18. Customise/personalize	Low	High
Usability and Aesthetics	F9. Camera appearance	High	Low
	F10. Display size	High	Low
	F11. Control command	Low	High
Usability	F5. Type of connectivity	High	Low
	F8. Connect with other devices	High	Low
	F14. Native apps	High	Low
	F15. Service for download apps	High	Low
	F16. User Guide	High	Low
	F17. Durability and safety	High	Low
	F1. Speed of processing	Low	High
	F2. Memory	Low	High
	F3. Capacity to extend memory	Low	High
	F4. Camera resolution/zoom	Low	High
	F6. Battery durability	Low	High
	F7. Display resolution	Low	High

4.3. Experimental stimuli

The pre-experimental phases have led us to design six smartphone models. These models were presented to the users as a list of attributes and specifications (See Appendix 3, e.g., Attribute: Memory (in GB of RAM), Specification: 32 GB) where for each simulated device (model) the participants were able to observe four pictures of smartphones available in the market, as examples of the comparable products.

We compared the attributes and specifications of each of the six smartphone models (Device 1–6) with similar products that could be found on 20 websites specialising in mobile phones to determine a preliminary range of price and monthly cost for each model. Then we asked five experts, each with more than 3 years of expertise on smartphones design and marketing, to express independently a percentage of agreement to the both the range of price and monthly cost we proposed for each model. Finally, for each device a price and a monthly cost were displayed to the participants (see Table 6).

TABLE 6. Six smartphones usability and aesthetics levels and associated price and monthly costs

Device code	Usability level	Aesthetics level	Price Range (in €)	Monthly cost (in €)
1	High	High	> 300	> 30
2	High	Low	200 – 250	20 - 24.99
3	Low	High	100 – 199	15 - 19.99
4	Low	Low	< 100	< 15
5	Mixed-high	Mixed-high	200 – 250	20 - 24.99
6	Mixed-low	Mixed-low	100 – 199	15 - 19.99

4.4. Experimental procedure

After the completion of the survey on personal characteristics, based on the QUIS items, the users were randomly assigned to assess one of the six device models. After the presentation of the overall schedule (Appendix 3), the users were invited to fill in an online survey composed of 24 items where they were asked to rate, separately, the perceived levels of usability and aesthetics, their overall preferences, the perceived value of the product and their intention to purchase. The experiment, followed a 2x2x4 factorial design with the three independent variables (Table 7) and six dependent variables (Table 8).

TABLE 7. Independent variables

Independent variables	Description
-----------------------	-------------

Level of usability	Low/high attributes of usability features
Level of aesthetics	Low/high attributes of aesthetics features
Level of product price/ monthly contract	1- > 300 / > 30 2- 200 – 250 / 20 – 24.99 3- 100 – 199 / 15 – 19.99 4- < 100 / < 15

We also tested, by a quasi-experimental design, the effect on the six dependent variables (Table 8) of the following aspects gathered by the section of personal characteristics (see Appendix 1):

- 1- Demographic characteristics of participants (from Q1 to Q4)
- 2- Participants declared level of expertise in the smartphone use (Q5);
- 3- Participants previous experience (Q6 and Q7);
- 4- Participants' attitude in use (Q8 and Q9).
- 5- Participants attitude in purchasing (Q10, Q10a, Q10b, Q10c)

TABLE 8. Dependent variables

Dependent variables	Description and items code (for description see Appendix 1)
Expected usability	Average score of responses for perceived usability (Items 1–8)
Expected aesthetics	Average score of responses for perceived aesthetics (Items 9–18)
Expression of user preference	Score of user preference (Item 19)
Perceived value	Average score of responses for perceived value (Items 20–22)
Intention to purchase (buy the phone)	Score of responses for Intention to buy (item 23)
Intention to purchase (enter a contract)	Score of responses for the intention to enter a contract (Items 24)

5. RESULTS

5.1. Manipulation check

Before the analysis of the experimental data, we tested the manipulation of the simulated devices to check whether the levels of aesthetics, usability and price that varied in the six

models, affected respectively, the perceived aesthetics, usability and value of the product before actual use.

The normality assumption and the homogeneity of ANOVA for the ratings of aesthetics, usability and value perceived were satisfied. The results revealed a significant effect of the aesthetics factor on the expected aesthetics ($F(5, 54) = 34.60$; $p < .001$). The mean ratings of aesthetics were 5.59 ($SD = 1.8$) and 3.77 ($SD = 1.25$) for the high and the low aesthetics conditions respectively. At the same time the usability factor affected the expected usability ($F(5, 54) = 24.81$; $p\text{-value} < .001$). The mean ratings of usability were 6.11 ($SD=0.93$) and 4.44 ($SD=1.42$) for the high and the low usability conditions respectively. This analysis, in line with previous studies (Lee & Koubek, 2010, 2011), showed that the manipulation of aesthetics and usability were successful. On the other hand, the manipulation of the price significantly affected the participants perceived value of the product ($F(5, 54) = 30.51$; $p\text{-value} < .001$).

Although, this analysis suggested that we have positively manipulated the levels of the aesthetics, the usability and the price of the simulated devices, in order to further investigate the participants' ability to discriminate among the different devices, we performed a multiple set of independent sample t-test. This analysis led us to compare the participants' ratings of the usability, the aesthetics and the preferences perceived before the use of Device 1 against all the other devices, by composing a rank of models (see Table 9).

TABLE 9. Rank of models based on the comparison of participants' ratings of Device 1 among all the others

Device code	Aesthetic		Usability		Overall preference		Preference Rank
	M (SD)	p	M (SD)	p	M (SD)	p	
1	6.11 (0.93)	---	5.19 (1.17)	---	5.90 (1.28)	---	1
2	4.17 (1.72)	.017	4.29 (1.43)	---	3.10 (1.80)	.001	4
3	4.73 (0.71)	---	3.11 (1.11)	.001	3.21 (1.24)	.001	3

4	4.43 (1.42)	.006	3.77 (1.25)	.018	2.80 (1.75)	.001	6
5	5.01 (1.10)	.004	4.76 (1.31)	---	4.98 (1.32)	---	2
6	4.27 (1.10)	.001	3.42 (0.88)	.001	2.99 (1.26)	.001	5

As Table 9 showed Device 1 (all-high attributes) was the most favoured product, while Device 5 (the mixed high) was the second in the preference ranking. Device 3, with high aesthetics and low usability, was the third in the rank, while the Device 2 (high usability and low aesthetics) was the fourth. Finally, the devices 4 and 6 with low levels of aesthetics and usability were the least favoured. This ranking order was in line with the results of the AHP test where the perceived aesthetics of the product was considered as more important than the usability for determining the overall preferences elicited from the users before the use.

The manipulation check suggested that participants can discriminate the usability and the aesthetics attributes of a product and, on the basis of this discrimination, they may estimate their overall preferences.

Finally, the differences among the overall preferences was not significant between the users that have assessed the Device 5 (mixed high) and Device 1 (all high), while there was a significant difference in the users' expected aesthetics of those devices (see Table 9, $p=.001$). At the same time, a t-test analysis between the participant preferences of Devices 4 (all-low attributes) and Device 6 (mixed low) revealed that participants could not discriminate between these products in terms of overall preferences, while a significant difference was identified between the perceived aesthetics of these devices ($t=3.29$, $p=.009$). These results, suggested that when participants have to judge the devices with similar levels of attributes, before the use, they could at least discriminate the aesthetics of the products. In light of that, we can conclude that the participants by analysing the schedules of the products before the use, could discriminate the differences among the models of devices we have used as in the experiment.

5.2. Test Outcomes

5.2.1. Hypothesis 1. Relationship among the perceived aesthetics, usability and product value.

For the participants' ratings we performed a descriptive and a Pearson correlation analysis among the aesthetics, the usability and the perceived value of the device (see Figure 3). The correlation analysis revealed the perceived value with both the usability (.427, $p < .001$) and the aesthetic (.210, $p = .037$) and that the usability and the aesthetics were positively correlated (.417, $p = .001$). For each device (Device 1 – Device 6) independently there was a significant correlation ($p < .001$) between the perceived aesthetics and usability, and between the perceived value and the usability while the relationship between the aesthetics and the perceived value was significant ($p < .05$) only when the level of smartphone aesthetics was high (Devices 1, 3 and 5).

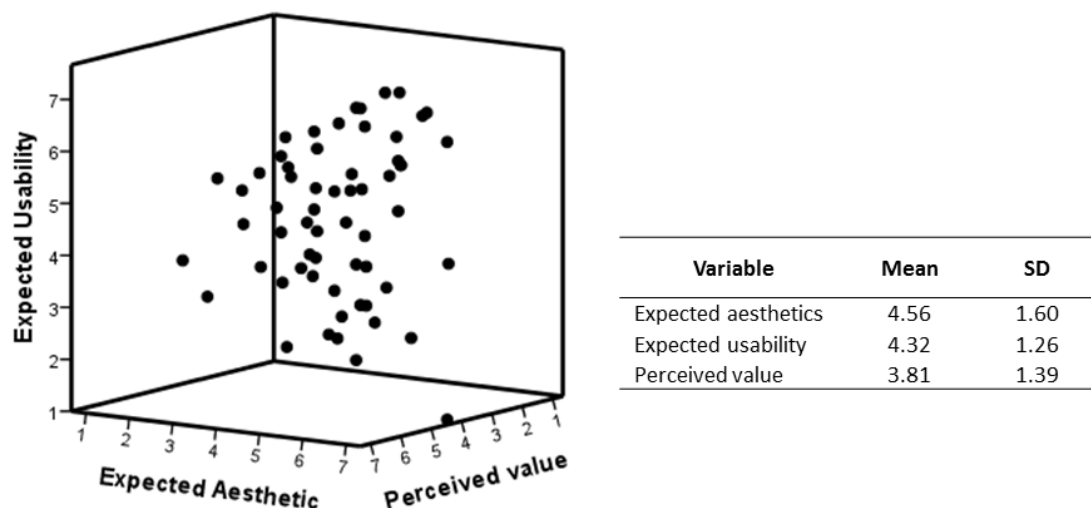


Figure 3 Descriptive statistics of the participants' ratings of the expected aesthetics, usability and perceived value before the actual use of the smartphone, and a scatter plot of the expected usability vs. expected aesthetics vs. perceived value.

5.2.2. Hypothesis 2. The effect of the differences in the aesthetics and the usability on the user preferences before the use.

A two way ANOVA was performed with two independent variables (the aesthetics level and the usability level) and one dependent variable (The expression of the user's preference before the use). The results indicated that the device aesthetics strongly affected the overall preferences before the use ($F(5, 54) = 5.55$; $p < .001$). Nevertheless, unexpectedly, the data revealed that also the levels of usability played an important role in the overall user preferences ($F(5, 54) = 3.55$; $p = .015$).

5.2.3. Hypothesis 3-1 The effect of the product price before the use and hypothesis 3-2 Factors that affect the users declared intentions to purchase

An ANOVA analysis was performed among one independent variable (i.e., the device price) and the four dependent variables (Expression of user preference, the expected aesthetics, usability and value of the product).

The user preferences were affected by different levels of the device price ($F(5, 54) = 7.91$; $p < .001$), as well as the usability ($F(5, 54) = 6.62$; $p < .001$), while price did not affect the aesthetics. Moreover, as we showed above the variation of the price also affected the perceived value of the product.

The user's final intention to buy a product was not affected by either the variation of the price or by the different levels of the usability and aesthetics. Nevertheless, our analysis revealed that there was a significant effect of the price on the intention to make a contract ($F(3, 56) = 3.05$; $p < .035$). In fact, the LSD analysis showed that the higher the price of the smartphone the higher is the intention of the user to make a contract for the phone.

In order to understand better the factors that may affect the users' intentions to buy and make a contract (i.e., intention to purchase) we performed a linear regression among the

user's preferences and the perceived characteristics of the product before use (usability, aesthetics and value). This analysis (see Table 10) showed that neither the perceived aesthetics nor the usability directly affected the intention to buy and make a contract, while the users' declared intentions were significantly affected by the perceived value of the product and the overall user preferences before the use.

TABLE 10. Effect on the intention to purchase (Buy or make a contract) of the perceived value and user preferences

Intentions to purchase	Predictors	β	p	Adjusted R ²
Buy the device	Perceived value	.355	.012	.326
	Overall preferences	.286	.032	
Make a contract	Perceived value	.314	.017	.399
	Overall preferences	.399	.003	

Finally, by considering the fact that the perceived value was strongly correlated with the perceived usability and only marginally with the aesthetics (Hypothesis 1), we performed a linear regression among those variables. This analysis confirmed that the perceived value was strongly affected by the perceived usability ($\beta = .421$, $p < .001$).

5.2.4. Hypothesis 4-1 Personal factors and preferences, and hypothesis 4-2 Personal factors, perceived value and intention to purchase

We performed a MANOVA among the personal characteristics (see Appendix 1) and the following dependent variables: the perceived usability and aesthetics, user preferences, the perceived value and the intention to buy and make a contract.

The analysis showed that among the participants' characteristics, the gender (Q1) and the level of education (Q5) did not affect the users' answers, while the age (Q2) affected the users' perceptions of the aesthetics ($F(5, 53)=4.59$ $p=.002$). In particular, the LSD test revealed that the younger the respondents the more important were the aesthetics and the usability of the device before the use. On the other hand, the country (Q3) of the participant strongly affected the perceived value of the device ($F(2,57)=6.81$, $p=.004$). The participants from the non-European countries were more likely to express higher ratings of perceived value than participants coming from the European countries irrespective of the levels of usability and aesthetics of the device under the assessment. Nevertheless, the origin of the participants does not affect their overall preferences or their intentions to purchase.

The level of expertise in using mobile phones (Q5) affected the participants' perception of usability before the actual use ($F(3,56)=2.81$ $p=.034$) and their intention to buy ($F(5,54)=2.68$ $p=.031$) or make a contract ($F(5,54)=2.47$ $p=.032$). In particular the LSD analysis revealed that the less of the experts the participants were the more likely they were to declare a higher intention to purchase the product.

The previous experience in using mobile phones has an effect; the number of different devices they used (Q6) slightly affected their perceived value of the device ($F(4,55)=2.91$ $p=.036$), while the number of operating systems (Q7) affected the expected usability ($F(5,54)=2.50$ $p=.039$).

The participant's attitudes in use (Q8 - Q9) and in purchasing (Q 10) did not affect their ratings of the dependent variables.

6. DISCUSSION

Our hypotheses were, at least partially, supported. Table 11 summarizes the testing outcomes for the hypotheses.

TABLE 11. Summary of tests outcomes for hypotheses of the empirical analysis

Hypothesis	Result	Meaning
Hypothesis 1	Supported	There was a strong correlation between the aesthetics and usability, and between the usability and the product value. Only at high level of device aesthetics there is a slight correlation between perceived value and perceived aesthetics.
Hypothesis 2	Partially supported	The user preference was significantly affected by both the differences in aesthetics and in usability.
Hypothesis 3-1	Partially Supported	The price of a product significantly affected the participants' ratings of the expected usability, value and user preferences, but not the aesthetics.
Hypothesis 3-2	Supported	The intentions to purchase were affected by the overall preferences and the perceived value of the product.
Hypothesis 4-1	Supported	The participant demographic characteristics (from Q1 to Q4) did not affect the user preferences, but these characteristics and declared expertise (Q5) affected in a different way the expected aesthetics and usability.
Hypothesis 4-2	Supported	The participant demographic characteristics (from Q1 to Q4) and previous experience (Q6-Q7) affect the perceived value of the product, while the level of expertise (Q5) affects only the user's intention to purchase.

The overall outcomes suggest that the process of user's preference making is related to the intention to purchase. However, while the users' preference-making is affected by the levels of the usability/aesthetics of a smartphone attributes and specifications, the user's intention to purchase is not directly affected by the differences of the product's aesthetics and usability.

The results of Hypothesis 1, in line with previous research on the pre-use preferences (Kurosu & Kashimura, 1995; Tractinsky, 1997; Tractinsky et al., 2000), show a correlation between aesthetics and usability, as well as between the perceived value of the product and the usability (Ben-Bassat et al., 2006). Moreover, our results suggest that the participants'

ratings of the value of a product are correlated with the perceived aesthetics only when the product has high aesthetics attributes.

The results of Hypothesis 2, in line with previous experiments (Lee & Koubek, 2010, 2011), suggest that participants can discriminate among the aesthetics and the usability attributes of a smartphone.

Our expectation was that, before the use the preferences are more affected by differences in aesthetics and the perceived value than by differences in usability, as was indicated by previous studies (Benbasat & Barki, 2007; Hassenzahl, 2004, 2008; Rotter, 1975) and was also supported by our pre-experimental AHP test. In order to further examine this assumption, we performed a chi-square analysis of participants' ratings. This analysis confirmed that the perceived aesthetic ($\chi^2=.472$) and the product value ($\chi^2=.386$) the users consider as more important than the usability ($\chi^2=.287$) for judging the product before the use.

These results suggest that before the use of a product, users who perceived a smartphone as aesthetically pleasing may tend to rate the device as more usable and more valuable than the users who perceive it as less aesthetically pleasing. When the device has low levels of aesthetics, the users tend to assess the value of the product by relying more on the perceived usability and the price. These conclusions are also supported by the results of Hypothesis 3-1. In fact, the information about the price of a product strongly affects the overall preferences, the perceived value and usability of the device, but not the perceived aesthetics. It follows that the aesthetics is the main determining factor for the user preferences; this factor is less important in their judgement of the value of the product or intention to purchase the product.

As the results of Hypothesis 3-2 show, the user's intention to purchase a product (buy or make a contract) is only indirectly affected by the attributes of the product, while this

variable is directly affected by the perceived value of the product and by the users level of preferences. In fact, as our analysis suggests a purchasing decision (i.e., buy or make a contract) is mostly affected by the user's perceived usability of the product before the use. In light of that, the perceived usability is the main driver for a purchasing decision of a user because it directly affects the factors that lead a user to buy or to enter a contract.

Finally, the results of Hypothesis 4-1 show that, depending on their personal characteristics, the users may rate the aesthetics and the usability of the product differently, but these differences do not significantly affect their overall preferences before the use. Still, there is some evidence that both the demographic characteristics and the user experience in using of a device affect their perceived value of the product, and their intention to purchase the product.

The personal characteristics affect directly the expectation of the perceived aesthetics and usability of a product and indirectly the overall user preferences before the use. Moreover, the personal characteristics directly affect the user's intention to purchase.

The empirical results of our analyses are presented graphically in Figure 4. Before the use of a smartphone, the user preferences are significantly affected by the different levels of aesthetics, price and usability of the product (i.e., observable intrinsic and extrinsic cues). The user reactions to product cues are determinant factors for the user preferences and their intention to purchase. The expected aesthetics, usability and value are strongly correlated before the use, nevertheless, only the usability affected the perceived value. Moreover, the personal characteristics of users do not affect directly the user preferences before the use, but those affected the expected aesthetics and usability. These results suggested that personal characteristics affect only indirectly the overall preferences (i.e., characteristics that affect the users' reactions) and the intention to purchase (i.e., characteristics that affect the intention to purchase).

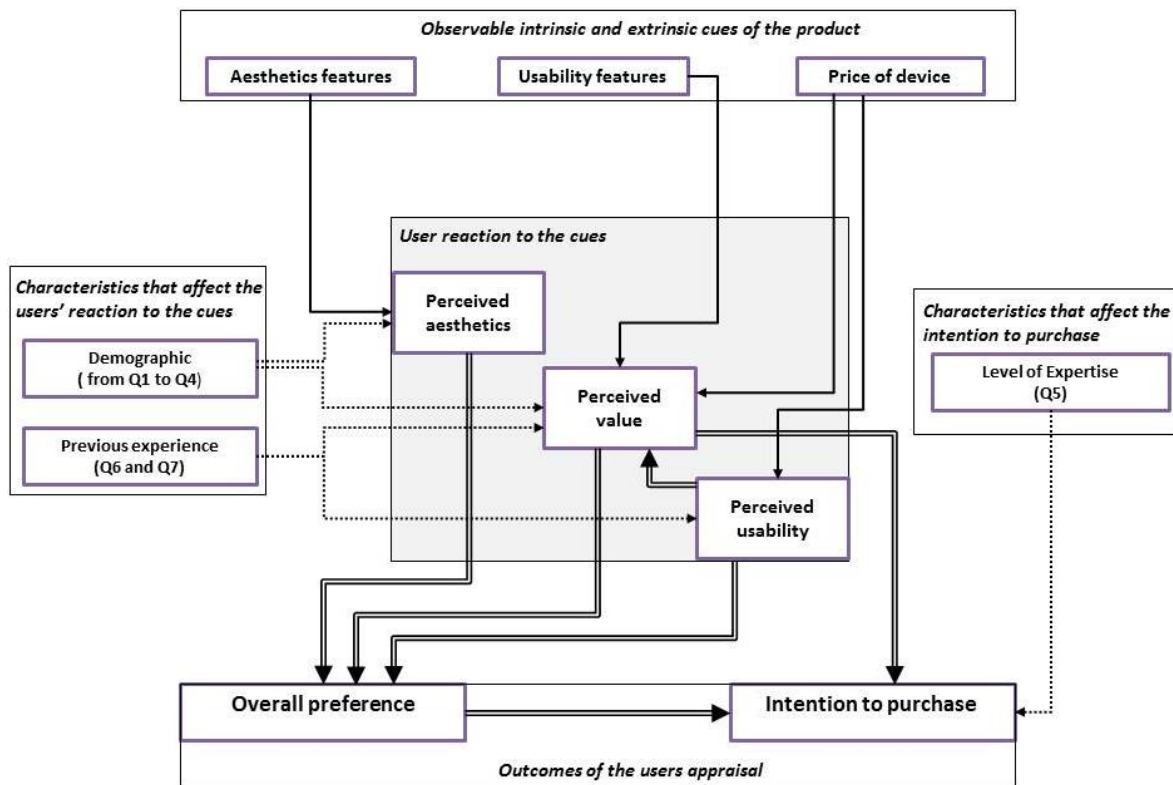


Figure 4. Effects on the overall preferences and the intention to purchase before the use of a product extrinsic and intrinsic cue, users' perception of these cues and the users' personal characteristics.

7. CONCLUSION

In this research our intention was to better understand what affects the users in their preference-making process and in their intention to purchase a smartphone, before the actual use of the device. We tried to find out the relationships among: the usability and the aesthetics attributes, the price, the perceived usability and aesthetics value of the product, the user preferences and their intention to purchase. We conducted a systematic empirical investigation by applying a revised version of the empirical protocol of Lee and Koubek (2010, 2011) for the user preference analysis. Our findings can be summarized as follows:

- the user preferences are directly affected by the perceived levels of usability, aesthetics and value of a product. Nevertheless, the main driver for the user's

preference appraisal before the use of the product is based on the perceived aesthetics of the product.

- the intention to purchase a product is directly affected by both the declared level of preferences and the perceived value of the product. The usability and the functionality of a product as perceived by the users before the actual use, can be considered the main determining factors in purchasing decision.

Smartphone users are able to discriminate, before the actual use of the product, among high and low specifications and, moreover, they are able to assess the quality of the product by considering the smartphone attributes related to the usability and the aesthetics. Our findings have at least two implications for the conceptualization process of a new product:

- to increase the probability of a successful product design the manufacturers should be guided by the data from the users' point of view to base their decision on features of a product they should focus on. For instance, on the basis of our data (see Table 3) for a smartphone manufacturer that aim to create a product for consumers similar to our participants, reducing the weight of the product is more important than increasing the battery durability.
- the aesthetic and the usability are two interrelated factors in the users' preferences in which the aesthetic has more impact before the use than the usability. In light of that, manufacturers may believe that design a high aesthetic prototype could be an easy way to lead users toward an overestimation of the product usability, hence increasing both the overall user preferences and the product's success on the market.

Nevertheless, as we showed, in tune with Ben-Bassat and colleagues (2006), products with high levels of user preferences do not directly turn in more purchasable ones. In fact, not only that the level of preference affects the purchasing decision but also the perceived value of the product is strongly affected by the usability and the price of the

product. Hence, in order to design a highly favoured and purchasable product, a manufacturer should create initial prototypes or mock-ups of a product with such levels of aesthetics, usability and price that are then assessed by a user evaluation process. The resulting trade-off among intrinsic and extrinsic cues of the product and the target end-users' needs and characteristics, may help manufacturers in pricing the product, and determining the core attributes and specifications of the product.

The approach we applied in this study can be easily replicated by researchers and manufacturers, varying the attributes under analysis, in order to test and to model the expected preferences before the use of a product, or, by replicating this approach with clustered groups of users. This approach can be used for testing different technologies (e.g., tablets, medical devices, home care and assistive products).

There are some limitations of this study that further studies will need to answer. First, we have observed only the preferences before the use of a smartphone. However, as Lee and Koubek (2010, 2011) underlined, the relationship among the usability, the aesthetics and the preferences could vary after the use. In light of that, further studies will have to apply our methodology also to assess the preferences and the intention to purchase after the use of a real prototype. Second, our study was based on a set of simulated products. The advantage of this approach is that practitioners may perform an analysis at the very beginning of the life cycle, when a real prototype is still not available. However, to perform a test with, at least, an image of the real prototype associated with the schedule may lead manufacturers to obtain a more prototype-specific set of user preferences and intention to purchase. Third, we attained the users' personal characteristics through a set of qualitative questions. However using specialist tools for analysing cognitive processes, skills or abilities (e.g., cognitive styles, shift of attention focus etc.) may lead researchers to identify more accurately the effects on preferences and intention to purchase. Finally, we have tested only the price as extrinsic cue

of a product, while the effect on the preferences and intention to purchase of other cues, such as brand, associated services etc. need to be considered. This may reveal other important factors that a manufacturer needs to consider in the process of the conceptualization of a new product.

ACKNOWLEDGMENTS

The authors acknowledge support of this work through the MATCH programme (EPSRC Grants: EP/F063822/1 EP/G012393/1), although the views expressed are entirely their own.

Appendix 1. Pre-use evaluation form.

Personal characteristics

1 - Participants demographic characteristics

Q1. Your sex/gender? (*Male/female*)

Q2. Your age? _____

Q3. Your educational level?

(*List of 12 options from 1. elementary school - to 12. Ph.D./other advanced*)

Q4. Country/Region of primary Citizenship where you live and use your smartphone? (*List of countries*)

2 - Participants declared level of expertise in the smartphone use

Q5. Please select the statement that best represents your expertise in smartphone use: (*From 1 - I am not expert to 5- I am professional expert - such as a designer of mobile phone app, programmer etc.*)

3 - Participants previous experience

Q6. Which Operating Systems of smartphones you have used in your life (please select all):

(*List of 12 options: 10 common OS, 1 option "I do not know", 1 option "Other OS: _____"*)

Q7. How many mobile phones have you owned in your life?

(*From 1- One device to 6- More than six devices*)

4 - Participants attitude in use

Q8. How much do you use a smart phone every day?

(*From 1- Less than 30 minutes to 6- More than six hours*)

Q9. Which of these common features of mobile phones are you used to use (please select all):

(*List of 12 options: 10 common features such as send an sms to surf on Internet, 1 option "I do not know", 1 option "I use all of these"*)

5- Participants attitude in purchasing

Q10. Usually I prefer to:

1. *Buy a device separately from a contract*

2. *Get a free (or cheap) device as part of a contract*

Q10a. (If answer 1) Usually how much you are likely to spend for a smartphone?

(*From 1 – Less than 100 to 4*

More than 300)

Q10b. (If answer 2)

Usually I prefer to select a contract that cost:

(*From 1 – Less than 15*

per month to 5 More than 30 per month)

Q10c. In your opinion which is the value on the market of your actual smartphone if you have to buy it as new?

(From 1 – Less than 100

to 4 More than 300)

Usability	Assessment of “Perceived Usability before Actual Use” – 7 points Likert Scale from Strongly Disagree to Strongly Agree <ol style="list-style-type: none"> Overall, I am satisfied with how easy it will be to use this smartphone. It will be simple to use this smartphone. I will be able to effectively complete any task using this smartphone. I will be able to complete any task quickly using this smartphone. I will be able to efficiently complete any task using this smartphone. I feel that it will be comfortable to use this smartphone. It will be easy to learn to use this smartphone. I believe I could become productive quickly using this smartphone.
Aesthetics	Assessment of “Perceived Aesthetics before Actual Use” – 7 points Likert Scale from Strongly Disagree to Strongly Agree <ol style="list-style-type: none"> I would probably be satisfied by the appearance of this new smartphone. I feel the design of this new smartphone would be aesthetic. I feel the design of this new smartphone would be pleasant. I feel the design of this new smartphone would be clear. I feel the design of this new smartphone would be clean. I feel the design of this new smartphone would be systematic. I feel the design of this new smartphone would be creative. I feel the design of this new smartphone would be fascinating I feel the design of this new smartphone would be original. I feel the design of this new smartphone would be sophisticated.
Preferences	Expression of “User Preference before Actual Use”– 7 points Likert Scale from Strongly Disagree to Strongly Agree <ol style="list-style-type: none"> If it was available on the market I would like to use this phone
Value	Assessment of “Perceived value/price of the product before Actual Use” – 7 points Likert Scale from Strongly Disagree to Strongly Agree <ol style="list-style-type: none"> Overall, I think the device will be good value for the money If I buy the device when it becomes available, I will be getting my money's worth. If I buy the device when it becomes available, I will be getting a good device for a reasonable price.
Intention to purchase	Expression of “Intention to buy or enter a contract before Actual Use” – 7 points Likert Scale from very low to very high

23. My likelihood of purchasing the new device when it becomes available is
 24. The probability I will enter a contract for obtaining this new phone when it becomes available is
-

Appendix 2. List of smartphone's attributes usually used for describing to users a smartphone model, and a set of high and low performance specifications for each device attribute.

Code	Attributes	Specifications
F1	Speed of processing	1.3 GHz
		1 GHz
F2	Memory (in Gb of ram)	32 GB
		4 GB
F3	Capacity to extend memory	The memory storage can be extended
		The memory storage can not be extended
F4	Camera resolution and zoom	8 Megapixel
		3 Megapixel
F5	Type of connectivity	Wifi and 3G
		Only 3G
F6	Battery durability	10 hours (talk time)
		7.5 hours (talk time)
F7	Display resolution	900X640
		800x480
F8	Tools for connectivity with other device (Bluetooth, USB)	Bluetooth and USB 2.0
		USB 2.0
F9	Camera appearance (position)	On front and back sides
		Only on front side
F10	Display size	More than 3.6 inches (a large display such as an Iphone, a Samsung Galaxy etc.)
		from 2.5 inches to less than 3.6 inches (a medium display, such as a BlackBerry, Samsung Ace etc.)
F11	Control command (touchscreen, keyboard)	Touchscreen
		Keyboard
F12	Device size	Large size device - 2.8x5x0.5 inches (70x127x12 mm)
		Medium size device - 2.4x4.3x0.4 inches (60x109x10 mm)
F13	Device weight	140g (quite light, similar to Samsung Galaxy3, Iphone5)
		200g (slightly heavy compared to Samsung Galaxy3, Iphone 5)
F14	Available native apps in the phone	Many Apps are already installed
		A few number of common Apps are already installed
F15	Service for downloading new apps	You can access to a large database, of free and paid apps
		You can access to a small database, of free and paid apps
F16	User Guide (Manual)	A paper version of the manual is provided when you buy the phone and you can also find the manual online
		A paper version of the manual is not provided when you buy the phone, but you can find it online
F17	Accessories for durability and safety	Many accessories available on the market
		Few accessories available on the market
F18	Accessories for customising and personalize	Many accessories are available on the market
		Few accessories are available on the market

Appendix 3. Schedule of smartphone models and visual stimuli.

You can see, by looking the schedule below, the usability and aesthetics attributes, and the specifications of a new model of mobile phone

	Features	Components
Usability	• Speed of processing	1.3 GHz
	• Memory (in Gb of ram)	32Gb
	• Capacity to extend memory	Yes, memory can be extended
	• Available native apps in the phone	Many Apps are already installed
	• Service for downloading new apps	Large database of free and paid apps
	• Camera resolution and zoom	8 Megapixel
	• User Guide (Manual)	paper version is provided when you buy phone, and you can find it also online
	• Type of connectivity	Wifi and 3G
	• Battery durability	10 hours (talk time)
	• Accessories for durability and safety	Many accessories available on the market
	• Display resolution	900X640
	• Tools for connectivity with other device	Bluetooth and USB 2.0
Usability and Aesthetics	• Camera appearance (position)	On front and back sides
	• Display size	More than 3.6 inches (such as the Iphone or Samsung Galaxy 3)
	• Control command	Touchscreen
Aesthetics	• Accessories for customising and personalize	Many accessories are available on the market
	• Device size	Large size device – 2.8x5x0.5 inches (70x127x12 mm) - such as the Iphone or Samsung Galaxy 3
	• Device weight	140g - quite light such as the Iphone or Samsung Galaxy 3
Price	Price of the Phone: More than 300,00* Monthly deal: More than 30,00*	

*Please consider the costs in £ if you live in UK, in € if you live European countries or in USA\$ for all the others countries

On the basis of these features, this new model of smartphone is similar to the following devices available in the market

Model name



Model name



Model name



Model name



In the next sections we will ask to you to assess your expectations on the usability, the aesthetics and the value of this new model of device

Next >>

References

Akins, R., Tolson, H., & Cole, B. (2005). Stability of response characteristics of a Delphi panel: application of bootstrap data expansion. *BMC Medical Research Methodology*, 5(1), 37.

- Ben-Bassat, T., Meyer, J., & Tractinsky, N. (2006). Economic and subjective measures of the perceived value of aesthetics and usability. *ACM Trans. Comput.-Hum. Interact.*, 13(2), 210-234.
- Benbasat, I., & Barki, H. (2007). Quo vadis, TAM? *Journal of the Association of Information Systems*, 8(4), 211-218.
- Borsci, S., Kurosu, M., Federici, S., & Mele, M. L. (2012). Systemic User Experience. In S. Federici & M. J. Scherer (Eds.), *Assistive Technology Assessment Handbook* (pp. 337-359). Boca Raton, FL: CRC Press.
- Borsci, S., Kurosu, M., Federici, S., & Mele, M. L. (2013). *Computer Systems Experiences of Users with and Without Disabilities: An Evaluation Guide for Professionals* London, UK: CRC Press.
- Chae, M., & Kim, J. (2004). Do size and structure matter to mobile users? An empirical study of the effects of screen size, information structure, and task complexity on user activities with standard web phones. *Behaviour and Information Technology*, 23(3), 165-181.
- Chin, J. P., Diehl, V. A., & Norman, K. L. (1988). Development of an instrument measuring user satisfaction of the human-computer interface, *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 213-218). Washington, D.C., USA: ACM.
- Choi, J. H., & Lee, H.-J. (2012). Facets of simplicity for the smartphone interface: A structural model. *International Journal of Human-Computer Studies*, 70(2), 129-142.
- Chuang, M. C., Chang, C. C., & Hsu, S. H. (2001). Perceptual factors underlying user preferences toward product form of mobile phones. *International Journal of Industrial Ergonomics*, 27(4), 247-258.
- Clodfelter, R., & Fowler, D. (2001). Do consumers' perceptions of product quality differ from objective measures of product quality? : University of Central Arkansas, Small Business Advancement National Center.

- De Angeli, A., Hartmann, J., & Sutcliffe, A. (2009). The Effect of Brand on the Evaluation of Websites, *Proceedings of the 12th IFIP TC 13 International Conference on Human-Computer Interaction: Part II* (pp. 638-651). Uppsala, Sweden: Springer-Verlag.
- De Angeli, A., Sutcliffe, A., & Hartmann, J. (2006). Interaction, usability and aesthetics: what influences users' preferences?, *Proceedings of the 6th conference on Designing Interactive systems* (pp. 271-280). University Park, PA, USA: ACM.
- Dillon, A. Beyond usability: process, outcome and affect in human-computer interactions. *Canadian Journal of Library and Information Science*, 26(4), 57-69.
- Dodds, W. B., Monroe, K. B., & Grewal, D. (1991). Effects of Price, Brand, and Store Information on Buyers' Product Evaluations. *Journal of Marketing Research*, 28(3), 307-319.
- Freling, T., Crosno, J., & Henard, D. (2011). Brand personality appeal: conceptualization and empirical validation. *Journal of the Academy of Marketing Science*, 39(3), 392-406.
- Glasscock, N. F., & Wogalter, M. S. (2006). Evaluating Preferences for Mobile Phone Features. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 50(12), 1259-1263.
- Good, P. (2000). *Permutation tests: a practical guide for resampling methods for testing hypotheses*. New York, NY: Springer-Verlag.
- Grewal, D., Monroe, K. B., & Krishnan, R. (1998). The Effects of Price-Comparison Advertising on Buyers' Perceptions of Acquisition Value, Transaction Value, and Behavioral Intentions. *Journal of Marketing*, 62(2), 46-59.
- Han, S. H., Kim, K. J., Yun, M. H., Hong, S. W., & Kim, J. (2004). Identifying mobile phone design features critical to user satisfaction. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 14(1), 15-29.
- Harper, B., Slaughter, L., & Norman, K. (1998). Questionnaire administration via the WWW: A validation & reliability study for a user satisfaction questionnaire, *WebNet 97*. Toronto, Canada: Association for the Advancement of Computing in Education.

- Hassenzahl, M. (2004). The thing and I: understanding the relationship between user and product. In A. B. Mark, O. Kees, F. M. Andrew & C. W. Peter (Eds.), *Funology* (pp. 31-42): Kluwer Academic Publishers.
- Hassenzahl, M. (2008). Aesthetics in interactive products: Correlates and consequences of beauty. In H. N. J. Schifferstein & P. Hekkert (Eds.), *Product experience* (pp. 287–302). San Diego, CA: Elsevier.
- Haverila, M. (2011). Mobile phone feature preferences, customer satisfaction and repurchase intent among male users. *Australasian Marketing Journal (AMJ)*, 19(4), 238-246.
- Işıklar, G., & Büyüközkan, G. (2007). Using a multi-criteria decision making approach to evaluate mobile phone alternatives. *Comput. Stand. Interfaces*, 29(2), 265-274.
- ISO. (1998). ISO 9241-11:1998 Ergonomic requirements for office work with visual display terminals – Part 11: Guidance on usability. Brussels, BE: CEN.
- ISO. (2010). ISO 9241-210:2010 Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems. Brussels, BE: CEN.
- Johnson, M., Firoozbakhsh, K., Moniem, M., & Jamshidi, M. (2001). Determining flexor-tendon repair techniques via soft computing. *Engineering in Medicine and Biology Magazine, IEEE*, 20(6), 176-183.
- Kurosu, M. (2010, Aug 3-5). *Concept Structure of UX (User Experience) and Its Measurement*. Paper presented at the Joint International Conference of Asia Pacific Computer Human Interaction and Ergofuture: APCHI & Ergofuture '10, Bali, ID.
- Kurosu, M. (2012a, May 5-10). *Psychological Considerations on Behavior and UX*. Paper presented at the Conference on Human Factors in Computing Systems: CHI '12, Austin, TX.
- Kurosu, M. (2012b, Sep 4-7). *Three dimensions of artefact design – meaning, quality and Kansei*. Paper presented at the Human Interface Symposium 2012, Fukuoka City, JP.
- Kurosu, M., & Kashimura, K. (1995). Apparent usability vs. inherent usability: experimental analysis on the determinants of the apparent usability, *Conference Companion on Human Factors in Computing Systems* (pp. 292-293). Denver, Colorado, USA: ACM.

- Lavie, T., & Tractinsky, N. (2004). Assessing dimensions of perceived visual aesthetics of web sites. *International Journal of Human-Computer Studies*, 60(3), 269-298.
- Lee, S., & Koubek, R. J. (2010). Understanding user preferences based on usability and aesthetics before and after actual use. *Interacting with Computers*, 22(6), 530-543.
- Lee, S., & Koubek, R. J. (2011). The Impact of Cognitive Style on User Preference Based on Usability and Aesthetics for Computer-Based Systems. *International Journal of Human-Computer Interaction*, 27(11), 1083-1114.
- Lewis, J. R. (1991). Psychometric evaluation of an after-scenario questionnaire for computer usability studies: the ASQ. *SIGCHI Bull.*, 23(1), 78-81.
- Lewis, J. R. (1995). IBM computer usability satisfaction questionnaires: psychometric evaluation and instructions for use. *International Journal of Human-Computer Interaction*, 7(1), 57-78.
- Lewis, J. R. (2002). Psychometric Evaluation of the PSSUQ Using Data from Five Years of Usability Studies. *International Journal of Human-Computer Interaction*, 14(3-4), 463-488.
- Linden, A., Adams, J., & Roberts, N. (2005). Evaluating Disease Management Program Effectiveness. *Disease Management & Health Outcomes*, 13(3), 159-167.
- Martínez Salinas, E., & Pina Pérez, J. M. (2009). Modeling the brand extensions' influence on brand image. *Journal of Business Research*, 62(1), 50-60.
- Ngo, D. C. L., Teo, L. S., & Byrne, J. G. (2003). Modelling interface aesthetics. *Inf. Sci.*, 152(1), 25-46.
- Pecchia, L., Martin, J., Ragozzino, A., Vanzanella, C., Scognamiglio, A., Mirarchi, L., et al. (2013). User needs elicitation via analytic hierarchy process (AHP). A case study on a Computed Tomography (CT) scanner. *BMC Medical Informatics and Decision Making*, 13(1), 2.
- Reinecke, K., & Bernstein, A. (2011). Improving performance, perceived usability, and aesthetics with culturally adaptive user interfaces. *ACM Trans. Comput.-Hum. Interact.*, 18(2), 1-29.
- Richardson, P. S., Dick, A. S., & Jain, A. K. (1994). Extrinsic and Intrinsic Cue Effects on Perceptions of Store Brand Quality. *Journal of Marketing*, 58(4), 28-36.

- Roto, V., Law, E., Vermeeren, A., & Hoonhout, J. (2011). User Experience White Paper. Result from Dagstuhl Seminar on Demarcating User Experience, September 15-18, 2010. Dagstuhl, DE: Dagstuhl Seminar on Demarcating User Experience.
- Rotter, J. B. (1975). Some problems and misconceptions related to the construct of internal versus external control of reinforcement. *Journal of Consulting and Clinical Psychology*, 43(1), 56-67.
- Sattler, H., Völckner, F., Riediger, C., & Ringle, C. M. (2010). The impact of brand extension success drivers on brand extension price premiums. *International Journal of Research in Marketing*, 27(4), 319-328.
- Schrepp, M., Held, T., & Laugwitz, B. (2006). The influence of hedonic quality on the attractiveness of user interfaces of business management software. *Interacting with Computers*, 18(5), 1055-1069.
- Seva, R. R., & Helander, M. G. (2009). The influence of cellular phone attributes on users' affective experiences: A cultural comparison. *International Journal of Industrial Ergonomics*, 39(2), 341-346.
- Sonderegger, A., & Sauer, J. (2010). The influence of design aesthetics in usability testing: Effects on user performance and perceived usability. *Applied Ergonomics*, 41(3), 403-410.
- Taylor, V., & Bearden, W. (2002). The effects of price on brand extension evaluations: The moderating role of extension similarity. *Journal of the Academy of Marketing Science*, 30(2), 131-140.
- Tractinsky, N. (1997). Aesthetics and apparent usability: empirically assessing cultural and methodological issues, *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems* (pp. 115-122). Atlanta, Georgia, USA: ACM.
- Tractinsky, N., Cokhavi, A., Kirschenbaum, M., & Sharfi, T. (2006). Evaluating the consistency of immediate aesthetic perceptions of web pages. *International Journal of Human-Computer Studies*, 64(11), 1071-1083.

- Tractinsky, N., Katz, A. S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers*, 13(2), 127-145.
- van den Heuvel, T., van Trijp, H., van Woerkum, C., Jan Renes, R., & Gremmen, B. (2007). Linking product offering to consumer needs; inclusion of credence attributes and the influences of product features. *Food Quality and Preference*, 18(2), 296-304.
- van der Heijden, H. (2003). Factors influencing the usage of websites: the case of a generic portal in The Netherlands. *Information & Management*, 40(6), 541-549.
- Wells, J. D., Valacich, J. S., & Hess, T. J. (2011). What signal are you sending? how website quality influences perceptions of product quality and purchase intentions. *MIS Q.*, 35(2), 373-396.
- Yun, M. H., Han, S. H., Hong, S. W., & Kim, J. (2003). Incorporating user satisfaction into the look-and-feel of mobile phone design. *Ergonomics*, 46(13-14), 1423-1440.
- Zhu, H., Wang, Q., Yan, L., & Wu, G. (2009). Are consumers what they consume? - Linking lifestyle segmentation to product attributes: an exploratory study of the Chinese mobile phone market. *Journal of Marketing Management*, 25(3-4), 295-314.